



CIRAD 

Genetically modified coffees

The experience of Cirad

Presented by Christophe Montagnon
Adviser for Coffee & Cocoa Matters


Coffee & Cocoa

Ico Mai 2005

CIRAD 

Centre International en Recherche
Agronomique pour le Développement

- ➔ **French state-owned organization (EPIC)**
- ➔ **1800 people including 900 scientists**
- ➔ **50 countries**
- ➔ **7 departments**
- ➔ **60 Research Units**

Agricultural research for development in the tropics


Coffee & Cocoa

Ico Mai 2005

CIRAD 

Centre International en Recherche
Agronomique pour le Développement


CIRAD has a mandate
To contribute to rural development in tropical and subtropical countries through :

- research
- experimentations
- research and development projects
- training operations in France and abroad
- scientific and technical information

Its operations include agronomic, veterinary, forestry, agrifood, economic and social research


Coffee & Cocoa

Ico Mai 2005


CIRAD 

Cirad & GM Coffees


Accumulation of knowledge on GM Coffees:

- **Strengths** (Only way to get genetic resistance to insects)
- **Weaknesses** (Overall agronomic performance / Coffee quality ?)
- **Opportunities** (Reduce chemicals use / Lower Production Cost)
- **Threats** (Impact on environment-Health / Public acceptance)

To the benefit of coffee stakeholders, specially the scientific community of producing countries, for discussions about GM Coffees / Total transparency


Coffee & Cocoa


Ico Mai 2005

CIRAD 


Two main activities

Today's presentation

- Genetic transformation and development of **GM Coffee**
 - Field trial of GM coffee trees (*C. canephora*) in French Guyana : targeted trait = resistance to leaf miner (model)
 - Searching for resistance (Bt Genes) to White Stem Borer and Coffee Berry Borer (In collaboration with India)
- Genetic transformation as a **tool**
 - Expression of Nematode resistant genes in transformed roots (activities)



Coffee & Cocoa

Ico Mai 2005


CIRAD 

Early work


- Find Bt Gene conferring resistance to Coffee leaf miner – Cry1 Ac
(Guerrero, O., Denoff, P., Pefieren, M., Decazy, B., Eskes, A.B., and Frutos, R. (1998) Susceptibility of the coffee leaf miner (Perileucoptera spp.) to *Bacillus thuringiensis* δ-endotoxins : a model for transgenic perennial crops resistant to endocarpic pests. *Curr Microbiol.* 36, 175-179.)
- Master the transformation with *Agrobacterium tumefaciens* & *rhizogenes*
- Built constructs (transgene) : Promoter 35S (all the plant) + selection genes (resistance to herbicide : Chlorsulfuron) + Cry1 Ac
(Leroy, T., Pallard, M., Royer, M., Sijak, J., Berthouly, M., Tessemau, S., Legrene, T., and Altoussier, I. (1998) Introduction de gènes d'intérêt agronomique dans l'espèce *Coffea canephora* Pierre par transformation avec *Agrobacterium* sp. In: ASIC (eds), 17th international colloquium on coffee science, Nairobi (Kenya), 20-25 July 1997, ASIC, Paris (France) pp 439-445.)
- Actually produce GM Coffees (Leroy, T., Henry, A.M., Royer, M., Altoussier, I., Frutos, R., Duris, D., and Philippe, R. (2000) Genetically modified coffee plants expressing the *Bacillus thuringiensis* cry1Ac gene for resistance to leaf miner. *Plant Cell Rep.* 19, 382-389.)
- Regenerate them (Berthouly, M., and Michaux-Ferrère, N. (1996) High frequency somatic embryogenesis in *Coffea canephora*. *Plant Cell Tiss. Org. Cult.* 44, 169-176.)


Coffee & Cocoa


Ico Mai 2005

CIRAD  Field Trial


- **In French Guyana**
France
No coffee neither wild nor grown
- **Strict reglementation**
Permission of the "Commission du Génie Biomoléculaire"
(Ministry of Agriculture)
One year full time scientist to prepare the demand to CGB
- **Transparency (Internet, Public information)**


Coffee & Cocoa


Ico Mai 2005

CIRAD  Field Trial

- **1 genotype = 58 transformed clones** (planted May 2000)
4 lines / 5 trees , 1.72 ha
- **Control = Same Genotype non GM**
- **Agronomic evaluation**
general habit
vigour and development
flowers and fruits
Chemical composition of fruits
- **Resistance to CLM (number of mines)**
- **Environmental Impact**
Influence on other insects
Pollen dissemination / honey composition


Coffee & Cocoa


Ico Mai 2005

CIRAD  Field Trial

Results (to be published)

Statistical Equivalence of GM and non GM Genotypes after four years in the field


- **General habit and vigor**
- **Flowers and Fruits**
- **Chemical composition of the fruits**


Coffee & Cocoa

Ico Mai 2005







CIRAD  Field Trial

Results

- **70 %** of GM trees are totally resistant to CLM
- Good correlation with western , bio –assays, and ELISA tests

Ico Mai 2005  Coffee & Cocoa


CIRAD  Field Trial


Field trial vandalized in August 2004 Lacking Results

- Yield (over several years)
- Analyses of coffee beans (over several years)
- Monitor the expression of the transgene / Accumulation of the insecticide protein.

Impact on environment


- Pollen dissemination
- Target and non target insect populations (preliminary result = no impact)
- Composition of honey (preliminary result = no difference)
- Concentration of protein in the plants

Ico Mai 2005  Coffee & Cocoa

CIRAD  Field trial

Conclusions

- GM Coffee plants are growing well
- GM Coffee have a significant enhanced resistance to CLM
- Lot of missing results specially on the impact on environment due to field trial vandalized

Ico Mai 2005  Coffee & Cocoa

CIRAD  Coffees



- Way forward
- Still to be add
- Impact on en
- Duration of re
- Monitor the e
- Find promote
- Use modern s
- GM Coffees an

Ico Mai 2005  Coffee & Cocoa

